MINNESOTA'S LANDFORMS: SHAPING OUR WORLD

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MINNESOTA'S LANDFORMS: SHAPING OUR WORLD

This unit is designed to acquaint you with the landforms and natural geologic features common to your local area and the entire state of Minnesota. Before you begin, send for the United States Geological Survey topographic map of your area. Instructions for ordering your map are found in the index to topographic maps, which is included with this unit.

MINNESOTA TODAY

Minnesota as we know it today, with its thousands of lakes, fertile farm land, rolling southern hills, and rocky northland, started its development billions of years ago when the earth was a new planet. Throughout geologic history, Minnesota has been a part of many natural changes, each helping to change the land into the Minnesota we see today. In the early days, molten lava often spilled out in great lava flows from the hot interior of the earth. High mountain ranges were uplifted and for millions of years they towered over the landscape until wind, frost, and rain eroded them away leaving only the ancient granite hills we see today west of Lake Superior's north shore.

During some periods of Minnesota's past the climate was much different from today. At some times, it was arctic cold and during others, mild and tropical. The Ice Age came about one million years ago, but this was only yesterday by geological time. Four great glaciers advanced and retreated across Minnesota, and when the ice finally melted, the face of the land looked very much as it does today. For this reason, any attempt to try to understand the landforms and topography of Minnesota also must include some study of the glaciers that played such a major role in shaping the surface of our state.

It is beyond the scope of this publication to offer an in-depth study of glaciation in Minnesota, however, two excellent sources are recommended for your reading.

1. *A Million Years in Minnesota — The Glacial Story of the State* by Edmund C. Bray.
2. *Minnesota's Rocks and Waters* by George M. Schwartz and George A. Thiel, Chapter 8.

Both of these publications will provide a detailed, easy to understand background on the Ice Age in Minnesota. These books both should be available in most libraries throughout the state.

ACTIVITY: Minnesota landforms

Materials: camera
magazines
paperback: *Landforms* — A Golden Guide

Procedure:

This activity will be a beginning to your understanding the landforms in Minnesota and how they were formed. An excellent reference for this project is the Golden Guide paperback, *Landforms.* This is readily available at libraries or at low cost at bookstores.

Listed on page 3 are many of the major landforms common to Minnesota. Look up each of these landforms and learn what they are. Then make a collection of pictures showing as many of these as you can find. Either take the pictures yourself or look through old magazines to find them.

Organize your pictures and descriptions into some sort of a display that could be used in helping others see and understand the landforms of Minnesota. This is a very open ended activity – use your imagination and creativity to develop an interesting project.

Landforms common in Minnesota:

Lakes	Terminal moraines	Bluffs
Rivers	Drumlins	Lava flows
Streams	Eskers	Sand dunes
Gullies	Outwash plains	Alluvial fans
Swamps	Kettle lakes	Floodplains
Oxbow lakes	Erratics	Meanders
Waterfalls	Sinkholes	Caves
Deltas	Potholes	
Sandbars	Hills	

ACTIVITY: Local landforms

Once you have become familiar with the general landforms of the state, start to focus on the landforms in your own area. Begin by making a list of those landforms you know exist in your area. This is also a good chance to get out and to look for landforms and other natural features. Excellent places to go in starting your list of landforms are small gullies, streams, rivers, gravel pits, and rock quarries. Look for any feature that has occurred naturally, no matter how large or small. A short canoe trip on a small meandering river is an excellent place to identify many natural features and landforms.

It is important however, to keep an organized record of what you see. You should start by setting up a chart similar to this one.

Description of the Landform	Location	How it formed

As you begin your study of landforms keep in mind that what you call something is not as important as giving it a good description. So start by describing what you see, if you know what it is called, use its name. But don't get hung up on names – they will come with time. Also, emphasize how the landform got to be like it is. To see something is one thing, but to understand how it got there is another. Remember too, that all the landforms you will ever see are only temporary features on the surface of the earth. At one time in geologic history they were not there, and sometime in the future they will be gone. As you study the landforms of Minnesota, you are studying them as they are today. In the future they will be changed by weather, erosion, and other natural or manmade events.

Running water is one of the greatest agents of erosion. The land is constantly being changed by water flowing both on the surface and below it. It is important to take an in-depth look at streams and rivers and to see the role they play in shaping the topography as we see it today.

The following activities are to be completed in what is called a stream table. A stream table is a small rectangular-shaped box with dirt or sand in it. It allows you to study running water scientifically in a controlled situation. The basic stream table set up is shown here.

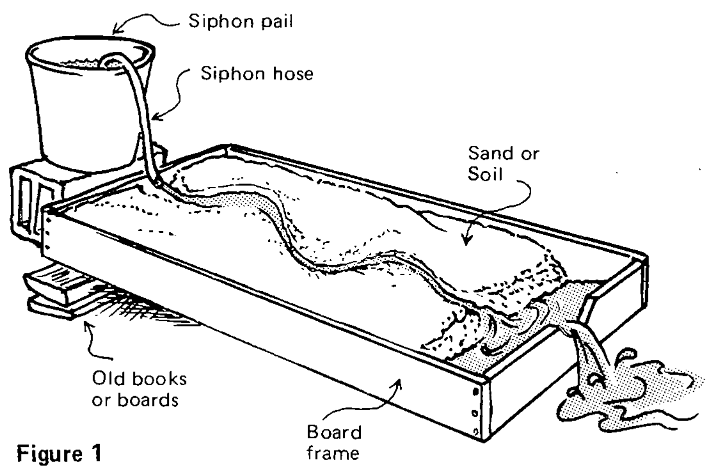


Figure 1

The size of the stream table can vary, but a good size to start with is about 16 inches wide by 48 inches long, by 4 inches deep.

ACTIVITY: Changes in a stream channel

It is often difficult in the field to observe the geologic processes that create many of the landforms. Nature usually works very slowly. But in your stream table you can speed up these natural changes and scientifically study some of the geologic principles that help to shape the land.

Materials: Basic stream table set up as shown earlier.

Procedure:

1. Fill the upper two-thirds of the stream table with sand.
2. Place five old books under the upper end to create a steep stream channel.
3. With your finger or a spade make a curvy channel the length of the sand. This channel should be about 2 inches deep.
4. Place the siphon tube in the bucket and start a medium flow of water down the channel. Never allow the water to overflow the stream banks unless you are trying to simulate flood conditions.

5. Direct the flow of water down the channel for 2 minutes. Then remove the hose.
6. Measure the width of the channel at its head, center, and mouth.
7. Change the elevation of the stream table to a gentle slope of only one book.
8. Again start a flow of water down the channel, being sure it does not overflow the banks.
9. Allow the water to flow down the channel for 10 to 15 minutes. Observe how the stream channel changes.
   a) Watch where the main current flows.
   b) Where is the most erosion taking place?
   c) What happens to the width of the stream?
   d) Where do sandbars form?
   e) Observe the delta at the mouth and how it changes.
   f) Watch for the formation of an oxbow lake.
   g) Does your stream get curvier or straighter?
   h) Remeasure the head, center, and mouth of your stream. Any changes?

Many other landforms can be created and studied in your stream table. Some you might like to try are waterfalls, lakes, alluvial fans, rockslides, shorelines, and faults. For a more complete backgound on stream tables and what they can be used for, contact an earth science teacher in either your junior or senior high school.

UNDERSTANDING AND USING TOPOGRAPHIC MAPS

LANDFORMS

To the geologist or earth scientist, the most important features on a map are the landforms that give shape to the earth's surface. All the details that make up the surface features of the land are called its **topography**. A map made to show these details is known as a **topographic map.**

The governments of most countries make topographic maps of their territories for military, scientific, and commercial use. In the United States, the Geological Survey has mapped a large part of the country. The results are available to the public in the form of detailed maps called **topographic sheets** or **quadrangles**. Most of these maps represent an area that covers 7.5 minutes of latitude and 7.5 minutes of longitude. Topographic maps are also available for some areas that are 15 minutes of latitude by 15 minutes of longitude.

USING TOPOGRAPHIC MAPS

Topographic maps almost always show the elevation and shape of landforms by using **contour lines**. A contour line is drawn on a map so that it connects all points on the ground of the same elevation. The shape of the contour lines gives us an idea of the shape of the land. The way these contour lines are able to show land features can be shown by using a small island as in figure 2.

The shoreline is one contour line connecting all places on the island at sea level or zero elevation. If sea level were to rise, a new shoreline with a new shape would be created. If the sea level should continue to rise, each time by the same amount, a series of new shorelines would be formed. Each of these new shorelines would represent a contour line used to show the

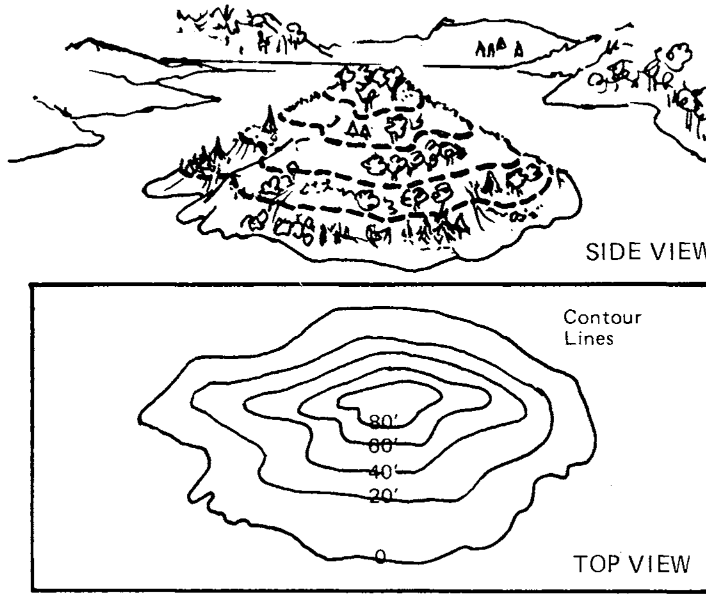


Figure 2

shape of the island at the various elevations. On an actual topographic map the contour lines are drawn from points of known elevations and aerial photographs. The contour lines are drawn to connect points on a map which are all the same elevation above sea level.

Contour lines that are next to each other usually connect points that differ 10 or 20 feet in elevation. The difference in elevation between contour lines that are next to each other is called the **contour interval.** On maps of very mountainous areas, the contour interval may be as great at 50 or 100 feet to prevent crowding of the contour lines. On maps of flat areas, the contour interval may only be 1 or 2 feet.

ACTIVITY: What do contour lines show?

Materials: plastic dish pan
irregular shaped rock that will fit inside the dish pan
ruler
small ball of moulding clay
chalk or crayon

Procedure:

1. Obtain a plastic dish pan.
2. Find a large irregular shaped rock and place it in the dish pan.
3. Insert the zero end of the ruler into the ball of clay and stick it to the bottom of the pan with the ruler standing straight up. (fig. 3)
4. Add water to the pan until the water level reaches the 1 inch mark on the ruler.
5. Wait until the surface of the water stops moving and **carefully** trace the water level with the chalk or crayon all around the rock.
6. Next add more water until the level reaches the 2 inch mark on the ruler. Then trace the new water level on the rock.
7. Repeat adding water and marking the level, until the water covers the rock or threatens to overflow from the pan. (fig. 4)

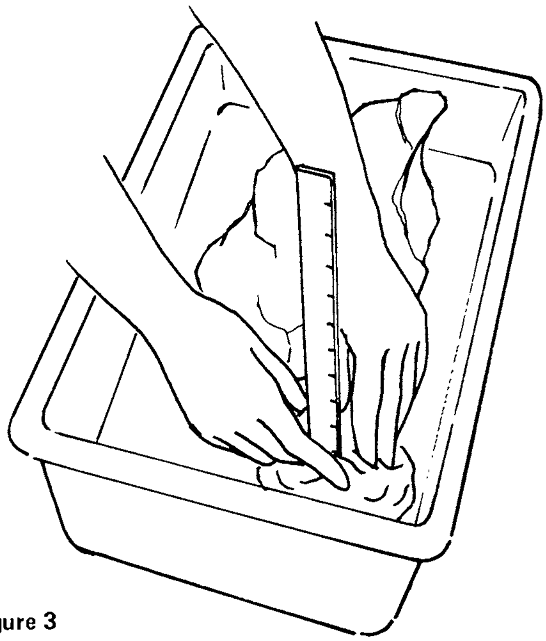


Figure 3

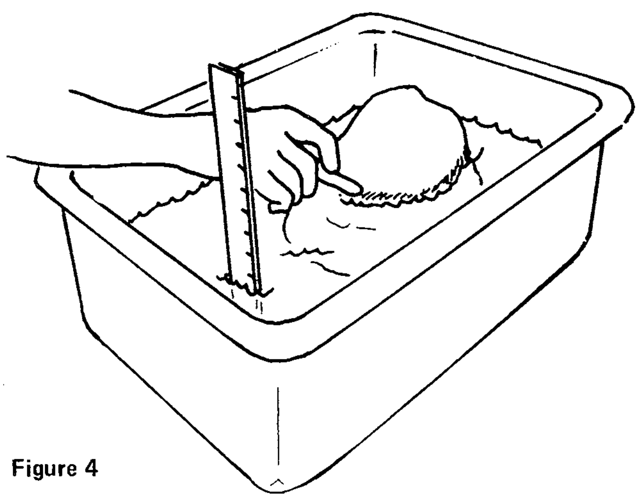


Figure 4

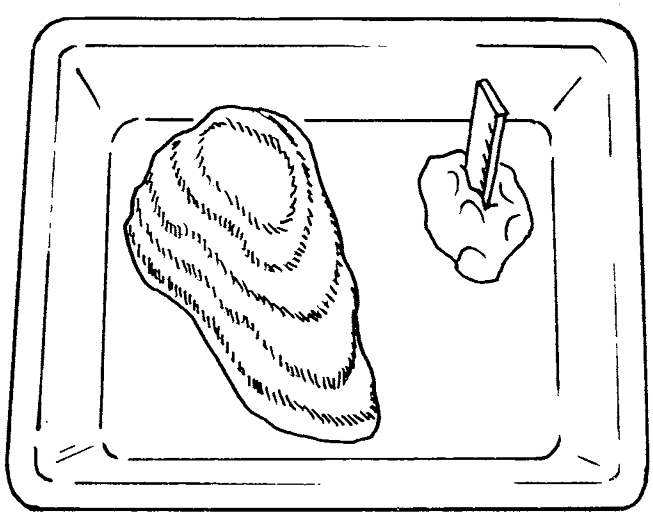


Figure 5

8. Pour out the water. You may also wish to go over some of the lines again to make them stand out more clearly.

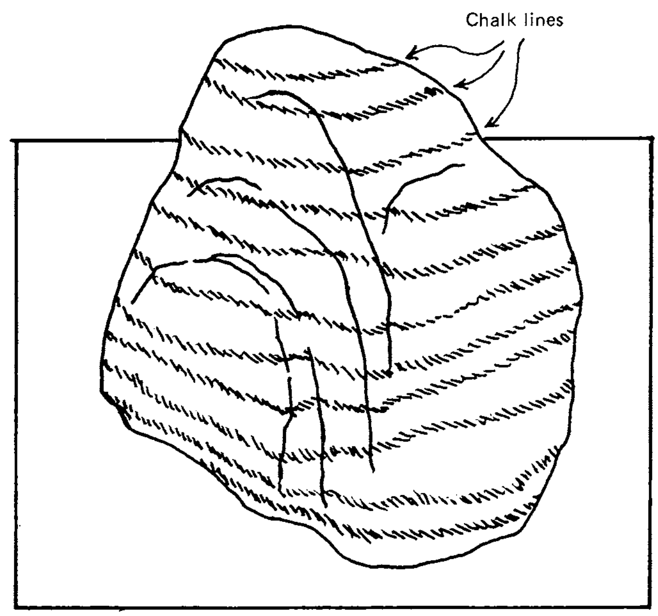


Figure 6

9. View the rock first from directly overhead. The lines that you see look exactly the same as **contour lines** on a contour map of that area. (fig. 5)
10. Now look at the rock from the side. Number the lines 1″, 2″, 3″, 4″, and so on. The distance on the ruler between lines is called the **contour interval.** (fig. 6)

Questions:

1. Why was it important to be sure that the surface of the water is still when the lines are being drawn?

____

____

2. What depth of water was added each time another line was drawn? ______________________________
3. At which height on the ruler did the **longest** contour line occur? ______________________________
4. At which height did the **shortest** contour line occur?

____

5. Where were the contour lines the closest together?

____

6. Where were the contour lines the farthest apart?

____

7. What was the contour interval on the rock? ________
8. What general shape do contour lines make when showing a hill on a topographic map?

____

ACTIVITY: Topographic build-up model

Materials: plain paper
several small cardboard boxes
white glue

Procedure:

1. Draw on a sheet of plain paper some imaginary contour lines similar to figure 7.
2. Obtain some cardboard boxes to cut up.
3. Select a large piece of cardboard to be your base.
4. Start with the contour line closest to the edge of your paper. Cut a piece of cardboard in the shape of this contour line.
5. Glue this shape to your base with some white glue.
6. Cut out the shape made by the next contour line and glue this in the position indicated by your drawing. Repeat this procedure for the other lines.
7. When this is finished, color or paint the base and the different layers. What you now have is the three-dimensional model of a flat map.
8. To carry this project even farther, try building a model of your own area by using a real topographic map from the United States Geological Survey.
9. Your models should turn out similar to figure 8.

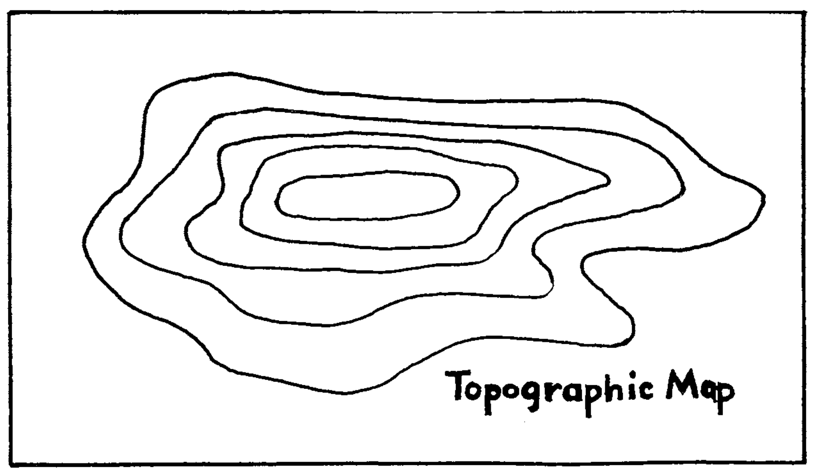


Figure 7

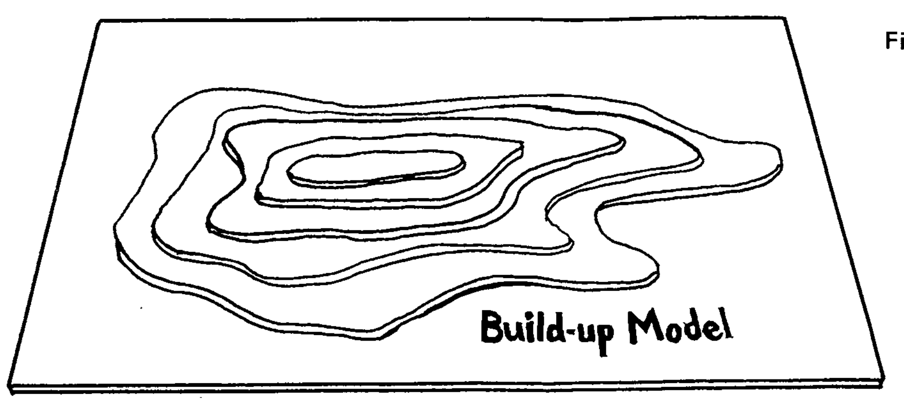


Figure 8

UNDERSTANDING A TOPOGRAPHIC MAP

Just as printed words on a page transmit ideas, contour lines on a map give a clear picture of the elevation, steepness, and shape of the land surface. It takes some training and practice before contour lines on a topographic map are easy to read, but it is not difficult to learn to use them.

Study the following basic rules carefully and keep them in mind when working with topographic maps.

1. A **contour line** connects all points having the same elevation. If a **contour interval** is 10 feet, contour lines will be shown for elevations of 10, 20, 30, 40, 50 feet, and so on. Usually every fourth or fifth contour line is heavier and darker. These are called **index contours** and are marked with a number showing its elevation. See figure 9.
2. Only the elevation of points directly on contour lines can be determined **exactly**. A point located between two contour lines has an elevation somewhere between that of the two lines next to it. In the sketch below, the elevation of point "A" is more than 320 feet but less than 340 feet. Probably it is very near 330 feet but we can't tell exactly. (fig. 9)
3. Sometimes exact elevations between two contour lines or at the top of a hill are known. These elevations are usually printed in brown or black ink and have one of the following symbols next to it: △, X, BM. See figure 9.
4. Contour lines spaced far apart show slight changes in elevation. See figure 10.
5. Contour lines spaced close together show rapid changes in elevation. See figure 10.
6. When crossing a valley, contour lines bend to form a "V-shape." The point of the V points uphill. If there is a stream flowing in the valley, the V in the contour lines will be pointed in the direction from which the water comes. This is called "the rule of V's." See figure 11.
7. Contour lines which form closed loops indicate a hill. See figure 11.
8. A hole or depression is indicated by using a special contour line with **hachures** on them. A hachure is a short straight line pointing in the direction of the depression. See figure 11.
9. The topographic map symbols can be found in the pamphlet called "Topographic Maps."

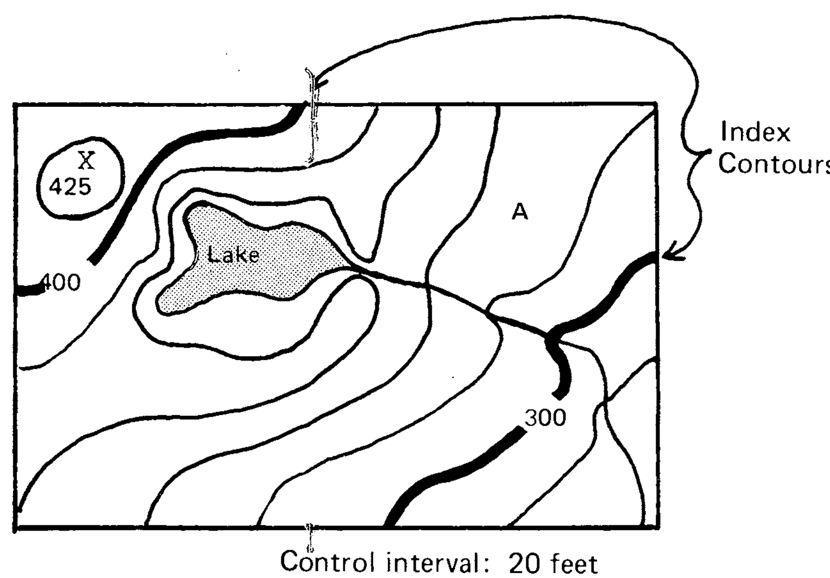


Figure 9

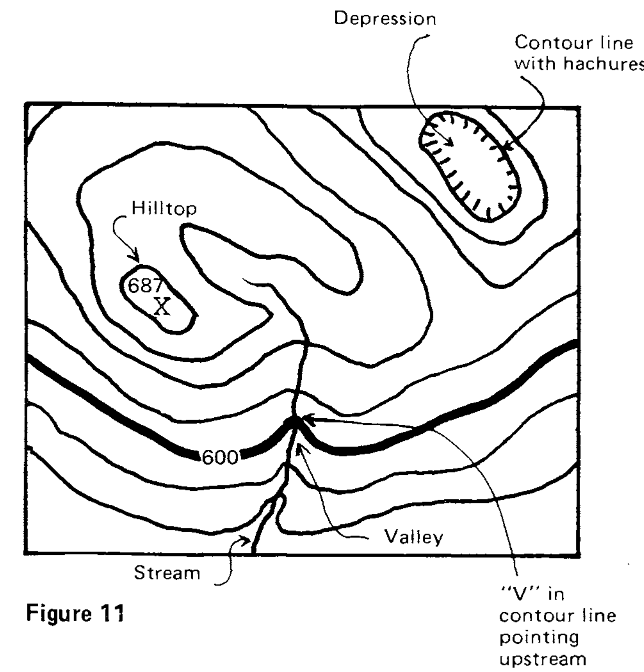


Figure 11

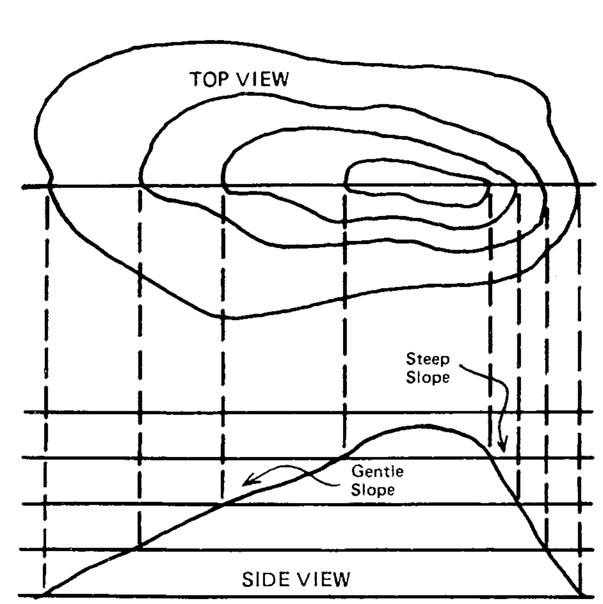
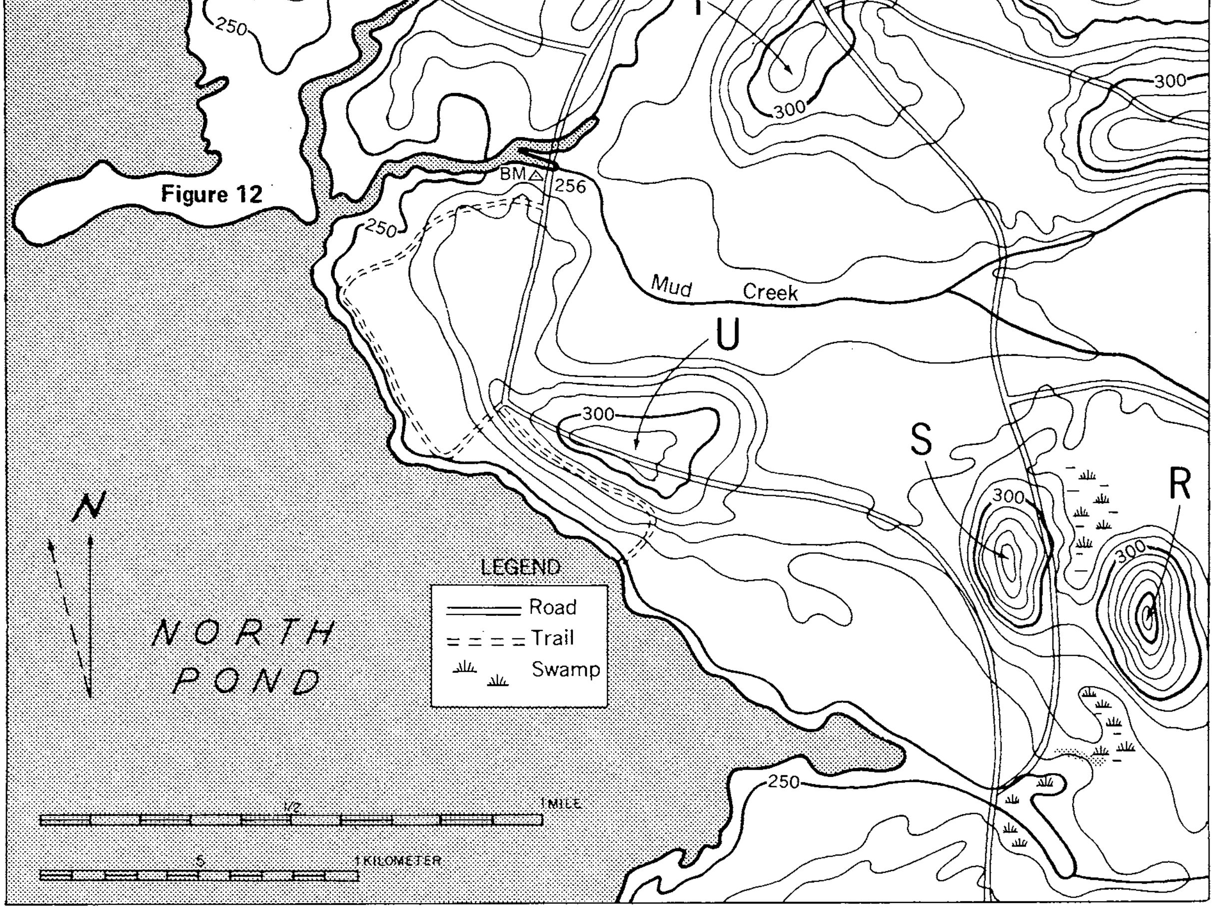


Figure 10



ACTIVITY: Reading a topographic map

Materials: Topographic map shown above.

Procedure:

Answer these questions using the basic rules you have just learned.

Questions:

1. What is the elevation of the closest contour line to North Pond? ______
2. What is the contour interval on this map? (How many feet?) ______
3. Which of the lettered hills has the highest elevation? ______
4. Which side of hill S has the steepest slope? ______
5. Using a piece of string and the scale provided, figure out how many miles of road are shown on this map. ______
6. In what general direction does Mud Creek flow? Use the rule of V's. ______

LOCATING LANDFORMS:

One of the most important uses of any map is to locate a particular point or place. One method of doing this is by using **latitude** and **longitude**. All topographic maps printed by the United States Geological Survey have the latitude and longitude printed along the edge.

Another method, and one more easily used, is to locate places by **township** and **range**. In the 1800s, settlers began to move into the Midwest. At that time a system of land boundaries was created to establish ownership. The basic plan was to divide the land surface into squares 6 miles on a side. These areas were called **townships**. Each township was subdivided into 36 **sections**. Each was usually 1 mile on each side and contained 640 acres. Each section could be further subdivided into half sections (320 acres), quarter sections (160 acres), or sixteenth sections (40 acres).

West of Pennsylvania, initial surveying points were chosen at irregular locations extending from the east to the west. From these initial points, a base line running east and west and a principal meridian running north and south were established. Lines were then run at 6-mile intervals parallel to the meridian and the base line.

East-west lines were called **township lines** and numbered consecutively north and south of the base line; for example, Township 1 North (T.1 N.) was the first row above the base line and Township 1 South (T.1 S.) was the first row below the base line.

North-south lines were called **range lines** and numbered consecutively east and west of the meridian lines; for example, Range 1 East (R.1 E.) is the first row east of the meridian line and Range 1 West (R.1 W.) is the first row to the west of the meridian line.

In Minnesota, township and range lines are measured from the fourth or fifth principal meridians. In figure 13 the township and range lines are indicated as they would be numbered from the initial point with Township "A" being T.2 S., R.4 E. This land measurement system conveniently divides the land into smaller subunits or townships.

Each township (6 miles on a side) was divided into 36 sections, each 1 mile square. Each section contains 640 acres.

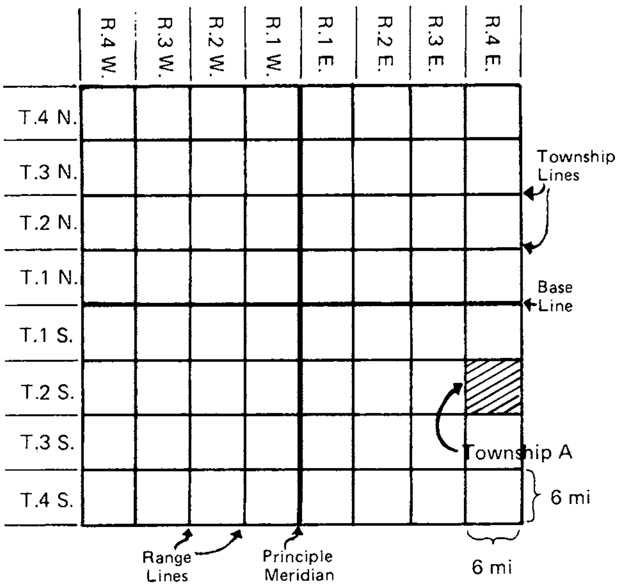


Figure 13

Each section was then divided into four parts of 160 acres each. These quarter-sections are further subdivided into quarter-quarter-sections, commonly referred to as "forties," each 1,320 feet on a side.

For legal purposes, each tract of land must have a description so that it will not be confused with another tract of land. This legal description has been designated by the original land survey and is on record in that county's courthouse. For example, the description of the tract of land in the following figure is legally designated as the NW¼, SE¼ of Sec. 16, T.145 N., R.37 W. of the 5th principal meridian, Clearwater County, Minnesota. (fig. 14)

LOCAL MAPS

By now you should have a basic understanding of the Minnesota landscape and how it got to be like it is, as well as a good idea of how to read and understand topographic maps. It is time now to study the topographic map of your local area and see how it shows the topography and natural landforms.

Before beginning this activity you must obtain a copy of your local topographic map and a map symbol sheet from the United States Geological Survey. Study the map carefully before you begin.

ACTIVITY:

1. In what year was this map last field-checked or updated?

   ____

2. How many feet is the contour interval on your map?

   ____

3. Find the highest point on your map.
   a) What is the elevation above sea level? __________
   b) What township is it in? __________
   c) What section is it in? __________
   d) What is its latitude? __________
   e) What is its longitude? __________
4. Find the lowest point on your map.
   a) What is its elevation above sea level? __________
   b) What township is it in? __________
   c) What section is it in? __________
   d) What is its latitude? __________
   e) What is its longitude? __________

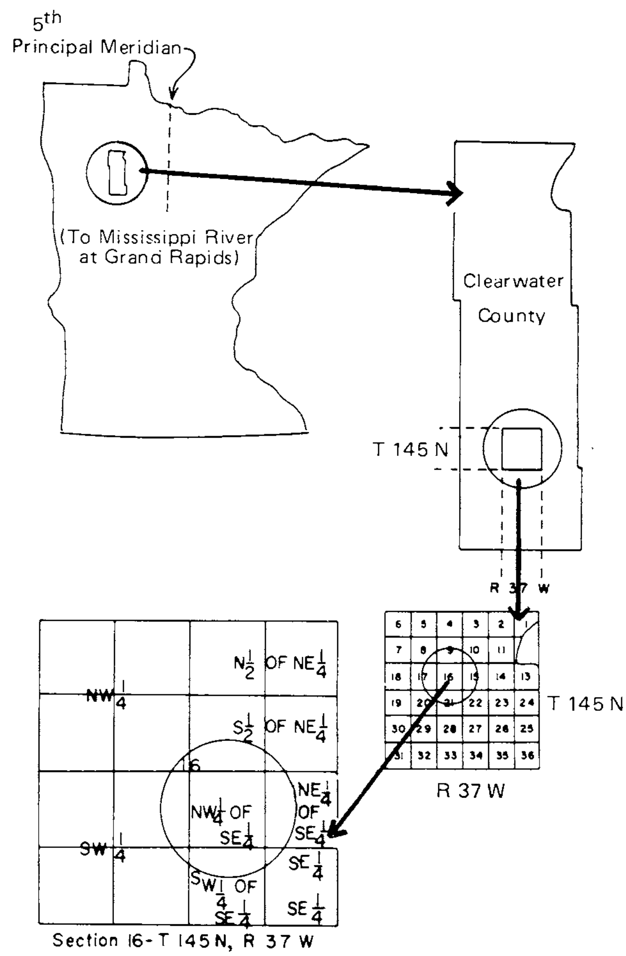


Figure 14

5. Find a river or creek on your map.
   a) Using a piece of string and the map scale, how many miles of this river or creek are found on your map?

      ____

      How many kilometers is this? __________
   b) Using the "rule of V's" that you learned earlier, in what general direction does this river or creek flow?

      ____

6. Find a lake on your map.
   a) Describe its location by township and section.

   ____

   ____

   b) What is its elevation above sea level?__________
   c) Does your map tell you how deep this lake is?______

7. Using your map and symbol sheet, make a list of as many **natural** features and landforms as you can.

   ____

   ____

   ____

   ____

8. Next make a list of all **manmade** features you can find on your map.

   ____

   ____

   ____

   ____

9. Find your own home or farm on your map.
   a) Describe its location by township, section, latitude, and longitude.

   ____

   ____

ACTIVITY: Contour build-up model

Earlier you learned how to make a three-dimensional build-up model of a simple topographic map using layers of cardboard. A similar project can be constructed using your own topographic map or part of it. Try to make an accurate reproduction of the topography and landforms in your area. This is a very extensive project but can be extremely rewarding if carefully completed. You might consider using thin plywood or masonite instead of cardboard for a more lasting project. The sky is your limit with a project like this.

ORIENTEERING (USING A MAP AND COMPASS)

Many of us grow up without ever appreciating the greatest show on earth — our natural outdoor environment. We become so preoccupied with various artificial things that we miss the main attraction. The woodlands, prairies, lakes, ponds, streams, swamps, hills, ravines, mountains, wildlife, everything that we see, hear, smell, and touch help us to increase our understanding of our natural environment. Your study of landforms and the natural environment should get you outdoors and possibly even into some wilderness areas.

Each year more and more people are getting outdoors to enjoy our natural surroundings. Many people stay on the roads and marked trails, but an increasing number take off on their own along little known paths or even cross country. For this reason, orienteering should be included in your study of landforms and natural features. As you get into unfamiliar territory it is important for you to feel comfortable with a map and compass. Basic map reading is an essential part of your general knowledge, especially if you wish to explore outdoors. Your ability to use a compass is an outdoor skill that will help to make you self-reliant and confident wherever you travel. It also opens up new chances for exploration as you begin to explore new areas that you have never been in before.

Orienteering is best learned in small groups with a leader. It would be impossible to properly present the topic in the space provided here. Schools and public libraries are excellent sources of information as are science teachers, scout leaders, or anyone already proficient in the skills of orienteering. We strongly recommend that your 4-H club form an orienteering club and together work toward a common understanding of maps and compass use.

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STUDENT PACKET ON LANDFORMS

- Index to Topographic Maps of Minnesota
- Map Symbol Sheet from USGS
- Recent Highway Map